Creating Optimal Broadband RealVideo™ 8 Content

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RealProducer™ Plus 8.0 Broadband Video Production Specifications

The following documentation details key information for encoding high bit rate broadband streaming video content using the RealProducer Plus 8.0. The information is based upon production work within the Broadband Systems Lab, in accordance with development from the Codec and Tools teams at RealNetworks from February, 1999, to June, 2000.

In reading through the specifications you will learn:

- Specifics of ramping up your video inputs to match Broadcast compatible standards.

- How to target the highest possible Video Capture and exporting to Uncompressed AVI.

- Methods of using the RealProducer Plus 8.0 encoding settings including "High Quality Resize", De-Interlace" and "Inverse Telecine".

New Features of RealProducer Plus 8.0

- The Best Quality Streaming Video on the Market Today.

- Near VHS quality at 500 kbps bitrate.

- Near DVD quality at 1.0 MBps bitrate.

- Film and Television framerates at 24 or 30 fps.

RealProducer Plus 8.0 will enable you to create the best quality, most competitive streaming video for any target audience. RealVideo 8.0 media is now optimized for bit rates up to 5 Mbps at real time, 30 fps, full-screen playback.

Additional features improving video quality include both "Two-pass Analysis" and "Variable Bitrate" (VBR) encoding modes.

Updated features include filters for "De-Interlace", "Inverse Telecine", and "High Quality Resize", all of which remove artifacts that tend to occur in all high-resolution video capture processes.

Descriptions of Features in the RealProducer Plus 8.0.

RealVideo 8.0 Codec

The result of a joint development effort between RealNetworks and Intel, this quantum leap forward in Web video quality allows for users to experience near-DVD quality video on the Internet.

Two Pass Analysis

Analyzes the individual frames of the source video file prior to encoding.

Redistributes bits within the encoded file, resulting in a noticeable improvement in the resulting encoded video quality. Will increase encode processing time by more than a factor of two.

Variable Bitrate Encoding

Increases quality of streaming video by allocating bits as bit rate is varied in playback.

Allows greater variation in bitrate allocation.

Allows the user to increase the startup latency of tbe encoded clip to increase video quality.

May increase the startup latency of the encoded clip.

De-Interlace Filter

Removes interlace artifacts from NTSC or PAL video input. Ideal for full screen (720x486 to 640 x480) video source.

Inverse Telecine Filter

Removes redundant frames or fields from video content. Should be used with content that was originally converted from 24 fps film to 30 fps video in a 3:2 pulldown process.

High Quality Resize Filter

Greatly improves video quality when resizing. Requires slightly longer processing time.

Loss Protection

Protects against packet loss by adding error correction codes and more keyframes to the video stream when possible. A dynamic algorithm that has minimal impact on quality, suitable for all streamed content.

Targeting Broadband Video – General Guideline Overview

Capture and Encode with Broadcast standard framerates of 30 fps, selecting either Quarter screen (320x240) or Fullscreen (640x480) or letterboxed window sizes near these ratios.

For Film Trailer or Film sequences at bitrates between 220 to 500 kbps and windows near to 320x240, crop the letterbox ratios to provide a widescreen presentation, select the "Inverse Telecine Filter" and use an audio codec of 32k voice.

For Music Videos with windows near to 320x240, crop as needed, use 'Inverse Telecine Filter" if shot on film, or "De-Interlace Filter" if shot on video.   Use the stereo audio codecs anywhere from 22 k for bitrates up to 300k; 44 k for bitrates between 300 to 450 kbps; and 64 k for bitrates above 450 kbps.

For Fullscreen Film or Music Videos, at near to 640x480 cropped and resized windows, and bitrates between 500 kbps to 1.0 MBps, use the 64 audio codecs.

Setting-up the Computer Platform for Capture and Encoding:

The majority of high bitrate media generated in the RN Broadband Lab has been developed on the Windows platform under the following perimeters:

OS	Windows NT, 98, 2000
Processor	400 MHz or greater processor. Suggested: PIII-800+
RAM	128 MB –best for full screen 720x486 video capture and encoding
RealPlayer	Best method: RealPlayer 8.0 – RealPlayer 7 is also possible.

Video/Graphics Display Cards

Using an optimized Video Display card on your system will enhance the capture, display and playback of high bitrate video media.

Cards such as the ATI Rage128 Pro-based series perform well with full screen playback using the RealPlayer.

Video capture card manufacturers may also suggest specific cards for optimized performance.

Using Optimized Video Data Arrays

Unless you are able to optimize your hard drive for high speed A/V data capture, you will want to purchase a video array to maintain a constant 30 frame per second high level data transfer rate.

The RN Broadband Lab uses 30 GB Rourke Video Raids – which are high capacity expandable SCSI and Ultra SCSI LVD arrays available for Mac, NT and UNIX.

Investigating Video Capture Cards For Video Capture to AVI File Generation:

Analog Input Source Video Cards:

There are a number of cards -as well as cards integrated with edit systems, on the market which provide a breakout box for Component cable input.

The Miro DC50 card with breakout box, from Pinnacle, provides ITU-R 601 broadcast industry standard image output, from full screen, 720x486 NTSC to 352x240 or 640x486.

Digital Input Source Video Cards:

There a several IEEE-1394 cards on the market to choose from, however some cards do not provide high quality Uncompressed AVI's.

The Cannopus DV Raptor Card captures at a DV 720x480 resolution, and provides an NTSC broadcast industry standard image output at full screen ITU-R 601 quality.

Investigating Video Capture Cards For Video Capture Direct to RealServer or .RM file

Live Video Input to RealProducer:

Targeting higher broadcast quality streaming video at bitrates above 220 kbps, RealNetworks is working with numerous video card companies to provide for high-end solutions in the broadband-targeted live card space.

Towards bitrates below 220 kbps, existing Brooktree based video card live solutions continue to provide acceptable performance for 320x240 windows, at 15-30 fps video frame rates.

Wiring & Cabling the Video Input System

Video – Analog Inputs:

Component input, using separate BNC cables for the Y, R-Y, B-Y and Reference signals from Beta SP, provides an optimal broadcast source capture. Composite and S-Video are typically used as input for streaming narrow band web video, but do not provide the highest quality results for broadband media. If Component is not an option then S-Video is preferable to composite.

Video – Digital Inputs:

Mini DV IEEE-1394 input from a DV deck or camera can provide high quality source if using a quality DV capture card. Some DV cards may add artifacts to the capture. Test and view the results of an Uncompressed AVI export before using or purchasing. See notes on cards below.

Suggested Video Capture Card Input Cabling:

These signals will transmit the data rate and resolution to create an optimum broadband source. Requires the use of higher end video capture cards that provide I/O breakout boxes and/or direct inputs as listed:

- Component (Y, RY, BY)

- IEEE-1394, "Firewire"

- CCIR-601, Serial Digital

The following formats will not transmit the data rates or resolution for an optimum broadband source but can certainly function for creating high bitrate video:

- S-Video

- Component BNC

- Component RCA

Source Material for Optimal Encoding

Use Broadcast Quality Video Tape Source

Recommended Broadcast Source Video Formats:

- Digital Beta, D-1, D-2, D-5

- High Definition Digital Wide screen: HD CAM or HDD5

- Beta SP

- DV CAM (Sony) or DVC PRO (Panasonic)

- Mini DV, IEEE-1394

- U-matic, 3/4" (if there is no other option in the above formats)

Analog Video Source:

For Analog formats the best quality broadcast source is Beta SP, using Component cabling into your capture system.

U-matic 3/4" also applies if this is the only format available. Tests indicate quality differences between the two formats when using appropriate video input connections, Beta SP proves to be cleaner than 3/4".

Avoid capturing off VHS altogether- the format is rarely used in Broadcast TV production, the quality will appear degraded once used in broadband video creation.

Digital Video Source:

The following Digital Broadcast ITU-R 601 formats all provide high quality source media: Digi-Beta, D-1, D-2, D-5; or High Definition Digital HD CAM or HDD5; or DVC Pro 25 (Panasonic), DV CAM (Sony); or IEEE-1394 Consumer Mini DV.

Post-Production facilities equipped with high-end editing or graphics systems can capture from any of the quality digital video formats listed above. Using a capture card with Serial Digital inputs will provide very high quality source, as long as the capture/edit system allows for a high quality AVI file format export.

Preparing the Source AVI.

Capture Settings, Frame Rate, Data Rate

Capture at a frame rate of 30 fps, Uncompressed or MJPEG 24 or 32 bit RGB color, 16 bps, 44 kHz stereo audio, and a file size less than or near to 2 GB, the maximum size of the Microsoft Windows AVI file format.

Set the video capture data rate to the maximum settings that your card allows: near 2400 KiloBytes/sec for 352x240 windows, to near 7200 KiloBytes/sec for 720x486 windows.

Redo your capture if the system reports frame dropping during the capture process.

For highest quality broadband video, we suggest capturing fullscreen video and allowing the "High Quality Resize Filter" in the RealProducer to resize your media.

Capture Window Size Settings

Full screen settings for optimum video source captures:

720 x 486	CCIR-601 or ITU-R 601 Serial Digital - 4:2:2 color sampled
720 x 480	"DV" IEEE-1394
640 x 480	"TV Square Pixel Aspect Ratio"

Quarter screen settings for optimum video source captures:

352 x 240	(Default capture setting on some video cards)
320 x 240	"CIF – Square Pixel"

Determining Edited Video Durations

Choose clips anywhere from 30 seconds to 5 minutes in length: attention spans are short on the web.

Experimentation with long duration video sequences from 12 minutes to 1 hour is encouraged, but requires more work on the encoding preparation side. (See notes on exporting AVI's.)

Adding fades to the audio and video at the heads and tails of the clips provides a smooth transition in playback; ending on a black frame is cleaner than allowing the player to end on a final image of the video clip.

Exporting to AVI or MOV

When exporting to AVI, maintain those same settings as per the captured digital video source; keeping the window size, audio, and color depth the same.

Make sure the color depth setting is set to millions.

Allow the RealProducer Plus 8.0, to do the resizing, filtering and cropping. You will find best results are achieved when working from the highest quality, uncompressed AVI's.

Follow the information in the next section on working with the 2 GB file size limit under Microsoft Windows OS.

NOTE: The same settings apply supporting 24 or 32 bit RGB .MOV file formats.

Creating Uncompressed AVI's in consideration of the 2 GB file size limit under Microsoft Windows OS.

The first step in exporting to the AVI file format is testing: run a few codec export tests with a 10-15 second sequence to determine the maximum length of uncompressed video you can achieve under the 2 GB file size limit. Then test importing the particular codec AVI into the RealProducer Plus.

For long format clips with durations of 12 to 60 minutes -given the 2 GB AVI file size limitation, the sequence requires exporting in increments. Determine the number of minutes you can export, and select the first frame and last frame of the duration on your media timeline. On your next export, select the following frame after your output to the the first frame of your next export. From there, encode the individual exported clips at the exact same size and settings, then edit the clips together again in sequential order with the .RM edit command line tool included with the RealProducer Plus.

Again, the maximum length to export your clips again depends on which AVI codec you are using.

Using RealProducer Plus 8.0 Settings for High Bitrate Encoding
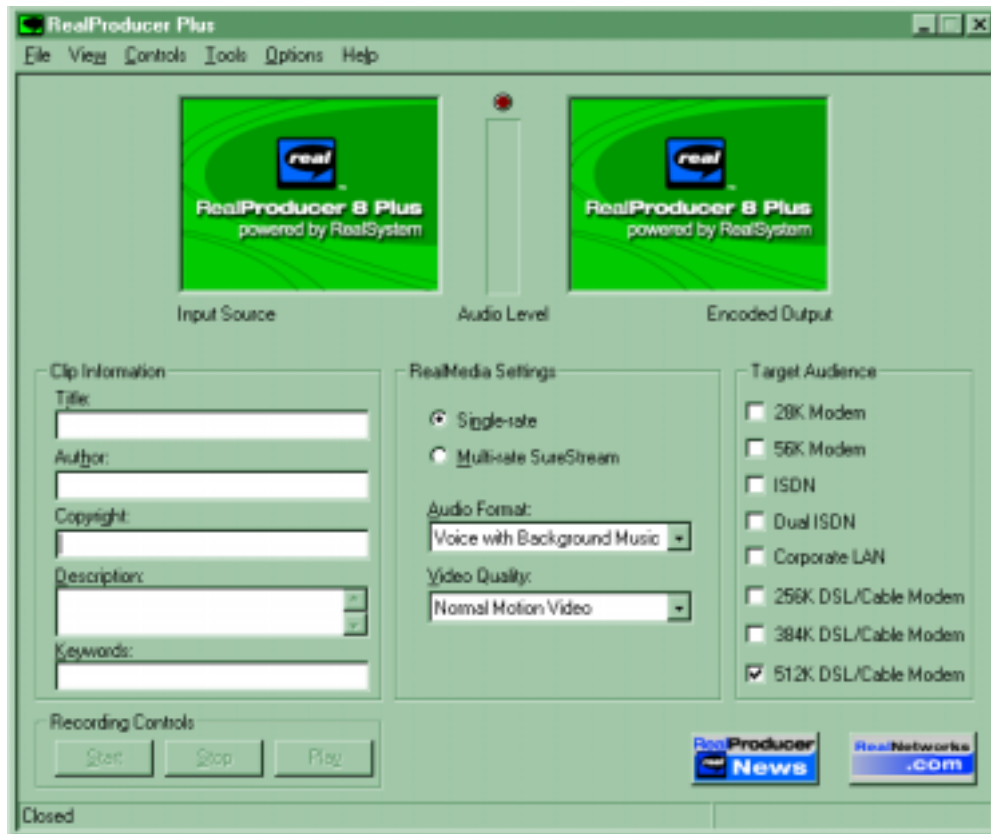
The following information details how to use the settings within the RealProducer Plus 8.0 to create high quality broadband video.
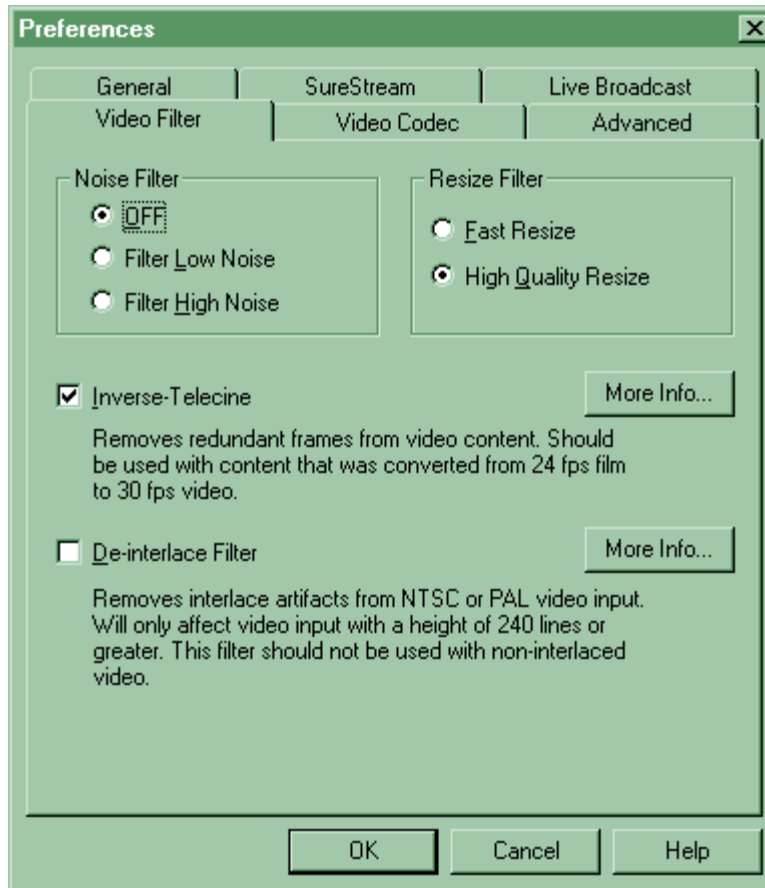
Low Bandwidth Encoding

For additional encoding information for narrow to mid-band bit rates below 220 kbps, refer to the "Working with RealProducer 8 Codecs" document located at:

http://service.real.com/help/library/blueprints.html

Selecting Video Filters

Options → Preferences → Video Filter

Noise Filter should be kept at OFF –unless the original content appears grainy, speckled or snowy. Low light or VHS quality source may be helped with this filter.

Resize Filter should be set to "High Quality Resize".

Video Filters: select either "**De-Interlace Filter**" or "**Inverse Telecine**" depending on the content source type.

Suggestions for Using Filters

For video taped content, such as news, sports, and TV Promos, select "De-Interlace" filter.

For 24 fps film transferred to video such as, feature films, music videos, etc., select "Inverse Telecine Filter" unchecking "De-interlace Filter".

For material that consists of a mixture or film and video taped content, select "Inverse Telecine", and also select "De-interlace Filter" if the number of lines is above 240.

Descriptions of Filters for "Inverse Telecine", "De-Interlace" and "Noise Reduction"

Inverse Telecine

When the source material is from 24 fps film, and then converted to 29.97 fps for tape recording, the Inverse Telecine filter in the Options->Preferences->Video Filters dialog box, should be enabled. De-interlacing should generally be disabled, unless the material has been post-edited, or is a mix of film and broadcast source.

The Inverse Telecine filter should be used both for full screen (720/704/640) and "quarter screen" (352/320 x 240) captures, as long as the source is 24 fps film.

De-Interlace

When the source material is from a broadcast 29.97 fps source, and the number of lines is above 240, the original AVI will have interlace artifacts, in the form of sharp jagged edges on moving object. If this is the case, the "De-Interlace Filter" under Options->Preferences->Video Filters, should be enabled. Generally, "Inverse Telecine Filter" should be disabled, unless, as mentioned in the section above, if the material is a mix of film source and broadcast material, both De-interlacing and Inverse Telecine should be enabled.

Noise

If your source material is from Beta SP or DVD, most often it will be of so high quality that you do not need to enable any of the noise pre-filters in the Options->Preferences->Video Filters dialog box. If, however, you can clearly see noise in the original AVI, you should experiment with either the Low or High pre-filters to see if they improve the final video quality. Both of these filters will, however, degrade the video quality in terms of smoothing out edges, and add some 'ghosting' to moving objects. Therefore, they should not be enabled unless necessary.

Notes on Third Party AVI Resize & Export Tools

Using 3rd party tools, full screen AVI's or edited sequences are often resized in software before exporting to RealProducer. Even when adding the "De-Interlace" filter option in these applications, most software resize exports can greatly reduce the quality of the video source. The Broadband Systems lab prefers to take the extra step to generate uncompressed, full screen AVI's and then scaling or resizing in the RealProducer Plus with the "High Quality Resize Filter" on.

Some video cards that provide hardware scaling (such as the Targa 3000 series) will produce a high quality resize. Testing is suggested if highest quality video is preferred. (Refer to "Definitions of Filters Below".)
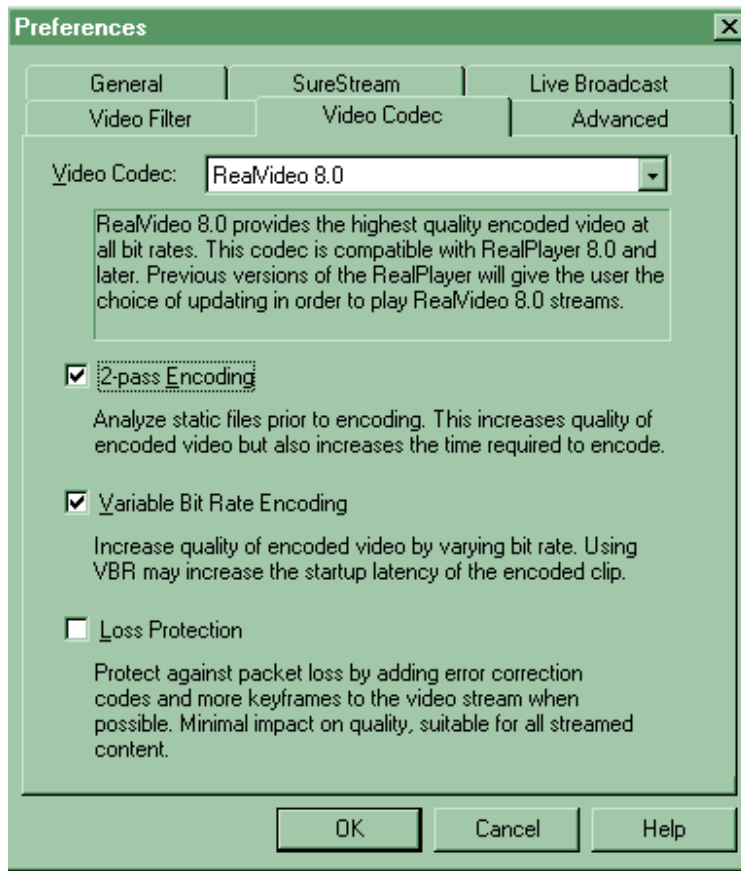
Selecting Video Codecs

Options → Preferences → Video Codec

Leave Video Codec setting at "RealVideo 8.0"

Select **"2-Pass Encoding"** and **"Variable Bit Rate Encoding"** for optimal video quality and playback performance.

Suggested: leave "Loss Protection" unchecked unless your content is to be streamed over networks with severe packet loss.

Descriptions of Two Pass Analysis and VBR Encoding

Two-Pass Encoding

With Two-Pass encoding, which is used only when encoding from a digitized source file, RealProducer runs through the entire source video once to gather information about how best to encode the streaming clip. It then makes a second pass to encode the streams. Two-pass encoding can substantially increase clip quality, but it requires more encoding time. The first pass takes about as long as it would to encode the source file for one target audience.

Although two-pass encoding helps when you use constant bit rate encoding, it provides greater benefit for variable bit rate (VBR) encoding, which is described above. With two pass encoding, RealProducer can analyze the entire video file to determine how best to vary the playback bit rate through the length of the clip. Without two-pass encoding, RealProducer sequentially analyzes small sections of the source file during encoding, creating a string of VBR sections within the clip.

Variable Bit Rate Encoding

Variable bit rate (VBR) encoding varies a RealVideo clip's playback bit rate, giving more bandwidth to scenes that are hard to compress, and less to scenes that are easy. Compatible with SureStream and broadcasting, VBR encoding generally provides superior video quality to constant bit rate (CBR) encoding, which RealProducer uses if you do not select the VBR option. VBR makes the most difference in videos that have a mix of high-action and low-action scenes because it can steal bandwidth from low-action areas to give to high-action areas. This is particularly useful for improving video quality at low bit rates.

To illustrate how VBR encoding works, suppose you encode a video for a DSL/cable modem audience at 225 Kbps. With CBR, the video gets 225 Kilobits of encoded data each second. With VBR, though, each second of video may be encoded at a different rate. One second may have 150 Kilobits of data, for example, while another second has 300 Kilobits. The VBR clip will have a streaming bit rate of 225 Kbps, though, just like a CBR clip. So you do not need to worry that a VBR clip will underuse or overload a connection's bandwidth.

A VBR-encoded video that starts with a high action scene needs a spike of bandwidth right away. If there are no preceding troughs to carry this data, RealPlayer has to buffer the clip longer. That means it may take the VBR clip longer than a CBR clip to start playing back. RealProducer lets you set the maximum time RealPlayer needs to buffer the clip, though, to ensure that the initial buffering time remains acceptable.
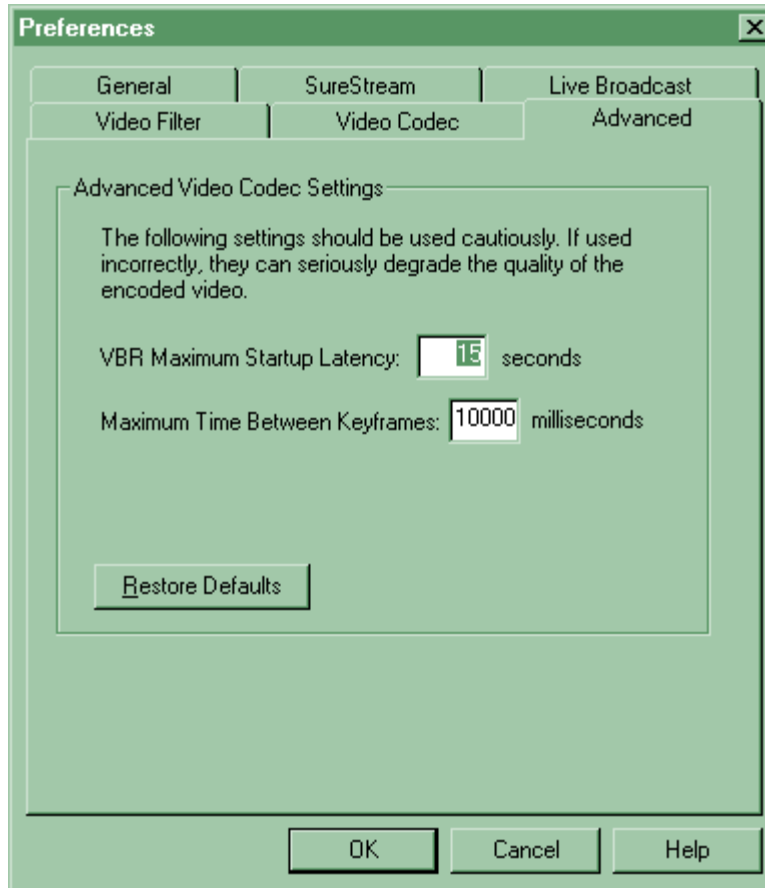
Selecting Advanced Video Codec Settings

Options → Preferences → Advanced

Suggestion: leave the default settings at 15 seconds for Maximum Startup Latency and 10,000 milliseconds for Maximum Time Between Keyframes.

When to Set the VBR "Maximum Start-up Latency"

The "VBR Maximum Startup Latency" field affects only RealVideo clips encoded with a variable bit rate (VBR), which is described in "

Variable Bit Rate Encoding" on page 14. A VBR video that starts out with a high-speed scene needs more initial buffering because the first scene is encoded at a playback bit rate higher than the audience connection speed. Because RealServer can't stream the scene faster without overloading the connection bandwidth, it streams it longer to deliver the extra Kilobits needed.

The latency field determines how long RealPlayer viewers may have to wait before a VBR video starts back. The default value of 15 seconds means that no matter how complicated the video's first scene, RealProducer will encode it so that it requires no more than 15 seconds to start playing. The field sets a maximum value only, and RealVideo VBR clips may start playback sooner. You can change the maximum to a whole value from 5 seconds to 25 seconds.

The value of 15 seconds is RealNetworks' recommendation. Keep in mind that this represents 15 seconds of clip data buffering, and does not include the time it takes to launch RealPlayer, find the host RealServer, send the request, and receive the host's response. If a low start-up time is critical, lower the latency time to 10 seconds, for example. For comparison, constant bit rate clips are encoded to have a latency of about 5 seconds. If initial image quality is crucial, you can raise the latency time, but this may cause restless viewers to stop the presentation before it begins playback.

Specifying Maximum Time Between Keyframes

RealProducer encodes full data for a frame in a keyframe. Successive frames encode just the data that describes how they vary from the preceding frame, starting with the keyframe. The "Maximum Time Between Keyframes "field is set initially to 10,000 milliseconds, meaning a constant or variable bit rate RealVideo clip has a keyframe at least every 10 seconds. The main reason to change the maximum rate is to lower it, although you should do this with caution. Lowering the rate generates more key frames for clips and provides several benefits:

- Minimizes distortion when streaming in a lossy environment.

- Improves RealPlayer's ability to seek to specific points in the RealVideo timeline.

- Adds flexibility for editing RealVideo clips through File>Edit RealMedia File. You have to cut a RealVideo clip at a keyframe, for example. More keyframes means more precise control over where the cut occurs.

Because keyframes encode much more data than other frames, though, lowering the maximum time between keyframes can lower the clip's image quality if you do not also raise the clip's streaming bandwidth. If you change the keyframe rate, test the clip quality to determine if the modification produced the desired results.
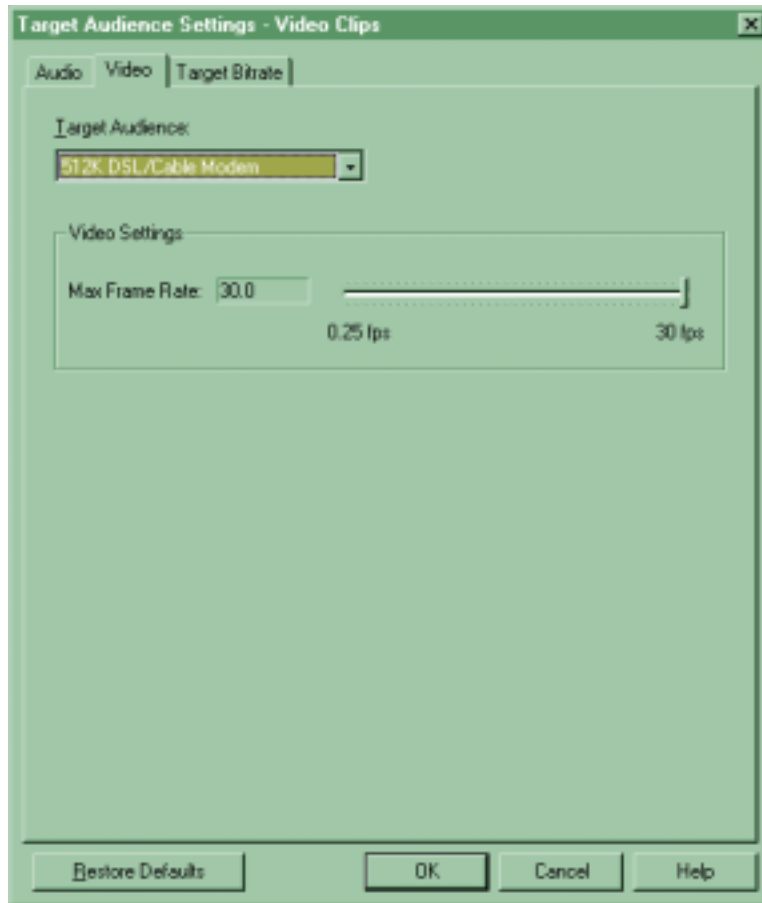
Selecting Target Audience Settings

Target Audience and Frame Rates
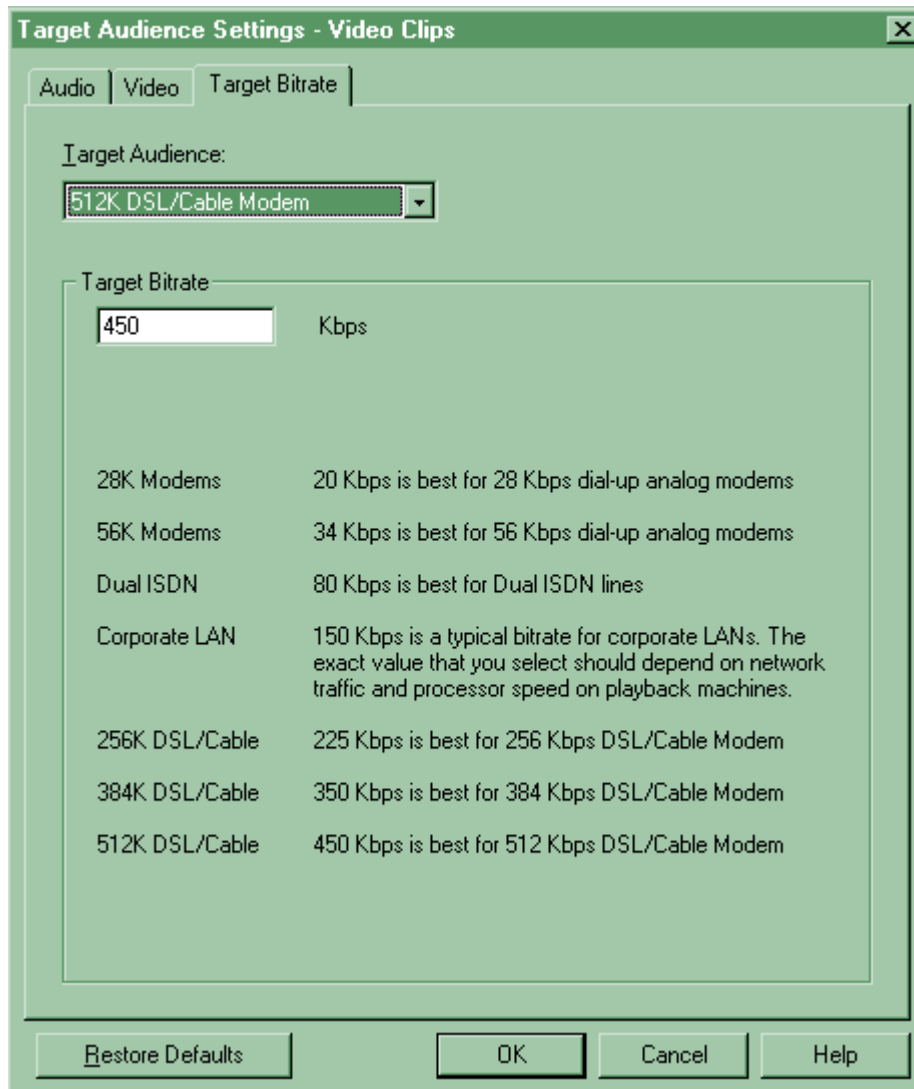
Options → Target Audience Settings → Video Clips → Video

Select your Target Audience setting to reflect your choice on the main interface.

Leave the "Max Frame Rate" default to 30 fps.

Note: If you have chosen the "Inverse Telecine" Filter, leave the setting at 30 fps. The filter will still generate a 24 fps encode, following the pattern of the source AVI if from a film transfer.

Target Audience Settings - Video Clips

Audio | Video | Target Bitrate

Target Audience:

512K DSL/Cable Modem

Target Bitrate

450   Kbps

28K Modems	20 Kbps is best for 28 Kbps dial-up analog modems
56K Modems	34 Kbps is best for 56 Kbps dial-up analog modems
Dual ISDN	80 Kbps is best for Dual ISDN lines
Corporate LAN	150 Kbps is a typical bitrate for corporate LANs. The exact value that you select should depend on network traffic and processor speed on playback machines.
256K DSL/Cable	225 Kbps is best for 256 Kbps DSL/Cable Modem
384K DSL/Cable	350 Kbps is best for 384 Kbps DSL/Cable Modem
512K DSL/Cable	450 Kbps is best for 512 Kbps DSL/Cable Modem

Restore Defaults   OK   Cancel   Help

Target Audience and Bitrates

Options → Target Audience Settings → Video Clips → Target Bitrate

Select the "Target Audience" setting to match the setting you have selected on the main interface.

You may choose from the default settings in the pull down menu, or enter your target bitrate manually in the available field at kilobytes per second.

Default bitrates for the Kbps pull down menu are indicated in this section.

The maximum bit rate setting allows up to 5000 Kbps (5.0 Mbps) bit rates.
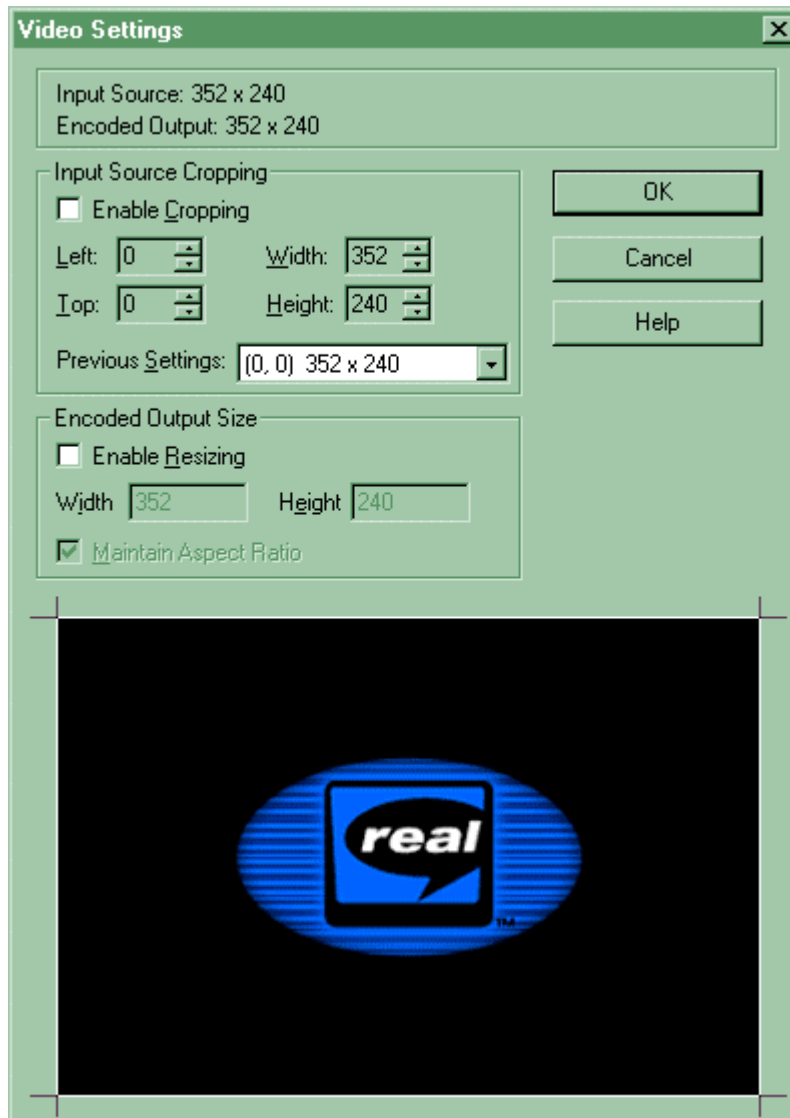
Video Settings

Options → Video Settings

Input Source Cropping: if you need to resize or crop your source file, set the window size to one of the following window sizes suitable for current broadband streaming standards:

If you have letterboxed souce AVI's use the cropping settings in the RealProducer Plus to remove the black bars along the upper and lower window for a streamlined experience.

For broadband content up to 500 kbps, a window width of 352 or 320 is a standard presentation measure.

Instructions for Determining When to Crop, Resize and Maintaining Aspect Ratio.

Cropping – Instructions for Full Screen Specifics:

For full screen AVI's, cropping all four sides of an AVI window is usually necessary. The black edges are due to the over-scanning of the video image during capture. Can also occur in letterbox source.

Video Settings->Input Source Cropping

Use the crop preview window to adjust the horizontal and vertical cropping measures. Generally 8 pixels on for each edge is a good starting point.

Video Settings->Encoded Output Size

Select "Enable Resizing" and uncheck "Maintain Aspect Ratio".

For resizing widths between 320 to 640, refer to the aspect ratio instructions below.

For standard fullscreen, computer-displayed presentations, set the width to 640. The height in the resize box should remain the same as the height determined in the crop setting

Tip: *If the first video frame is black, and you only see black in the crop preview window, then approximate the crop settings, turn off "2-Pass Analysis", and run a quick encode for a several seconds. Watching your output window will allow you to view where the cropping occurs. Remember to turn on "2-Pass Analysis" when to begin the final encode.*

You can also open the AVI in mplay32.exe (or mplayer.exe on 98), and align this player over the crop preview window to help to select the proper cropping measures.

Aspect Ratios

For both full size and quarter size AVI's, it is important to be aware of the aspect ratio as the computer screen pixel aspect ratio is different than the aspect ratio on a TV monitor.

If the original AVI source is already 320 or 640 wide, and appears to be aspect ratio corrected, you should then leave the "maintain aspect ratio" option checked, if additional resizing is necessary.

However, in most other cases following the steps below will provide the best results:

AVI source widths between 704 to 720 should be resized to 640 output for fullscreen presentations. Make sure you do not resize the height -as discussed above.

When resizing full screen AVI source widths to an output window size between 320 to 640, scale the aspect ratio manually. In most cases when leaving the "Maintain Aspect Ratio" setting checked, the result may appear slightly stretched. This may often go unnoticed.

AVI source widths near 352 can be resized to 320, to maintain a 4:3 aspect ratio. Leaving the 352 AVI source at 352 during encoding can also suffice, although there may be some chances of stretching. This may often go unnoticed.

Viewing and Using Video Quality Statistics During the Encoding Process:

Understanding the "Video Quality Index"

The "Video Quality Index" is the most essential tool to avoid overspending bits, or creating poor quality videos. It is not entirely obvious where to find it, and it has not been working well in previous versions of RealProducer. However, it has now been hooked up to the codec internals and provide a very useful indication of the video quality.

Where and When to Use the Tool

You can find the "Video Quality Index" by clicking View->Statistics, and then clicking the Video tab. In the RealPlayer G2 section, there is a list of the streams you are encoding. For single-rate there will only be one. The next to last column contains the video Quality Index. You should examine this quality index while you are encoding. For 2-pass, it only makes sense during the 2nd pass.

Overspending Bits

If you see that the index is 94 or above, consistently, then you know the tools is overspending bits. Consider one of the following practices when this occurs:

1. Lower the bitrate to save bits without sacrificing much quality,

2. increase the resolution, without increasing the bitrate,

3. increase the target frame rate, as long as it is not already at the maximum. Note that the encoded frame rate is limited by the source frame rate (the first choice will save bit rate, and the two others choices will increase video quality).

Poor Quality

If the number is constantly below 40, or even lower, you are running very low on bits, and if you cannot increase the bitrate, you should consider lowering the resolution or target framerate you are encoding for.

Best Target

In general, the RealVideo 8 codec is most efficient when it can operate in the range between 60 and 94. If your target is very high quality, you should try to keep it above about 80, but not so high that you are overspending (see above).

Playback: Use the RealPlayer 8.0 for best possible playback.

Fullscreen playback looks & plays better than ever in RealVideo 8.0, however the video can also be played in the RealVideo 7.0 player.

To ensure the best possible Broadband Experience at full screen playback in the RealPlayer 8.0, refer to the section above on upgrading video graphic display cards.